

# Linewidth enhancement factor measurement by using phase modulation method for epitaxial quantum dot laser on silicon

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The amplitude-phase coupling, namely the dynamic change of the active medium refractive index in relation to changes of the gain, commonly characterized by the linewidth enhancement factor ( $\alpha_H$  factor) reflects a basic characteristics of semiconductor lasers [1]. Here, we measured the above-threshold  $\alpha_H$  from the amplitude-phase coupling in a silicon-based epitaxial quantum dot (QD) laser using an optical phase modulation (OPM) method [2]. The laser under study is an InAs/GaAs Fabry–Perot (FP) laser made with five QD layers grown on an on-axis (001) Si wafer [3]. In the set-up depicted in Fig.1(a), the bias current of laser is set to twice the threshold (72 mA). The QD laser was modulated by the RF generator with a modulation frequency of 8.5 GHz. Meanwhile, the phase modulator was also modulated by the same frequency. The optical delay line (ODL) is used to control the delay between the optical and electrical signals at the input of the phase modulator. The frequency dependence of the amplitude phase coupling reads as  $\alpha(f_m) = \alpha_H [1 + (f_c/f_m)^2]^{1/2}$  with  $f_c$  the corner frequency and  $f_m$  the modulation frequency [1]. The analysis of the side mode dynamic on the optical spectrum is used for extracting the amplitude phase coupling and subsequently the  $\alpha_H$  factor at  $f_m \gg f_c$ . Fig. 1(b) depicts the optical spectrum and the corresponding  $\alpha_H$  factors extracted for 19 longitudinal modes near the gain peak. We demonstrate very low values of the above threshold  $\alpha_H$  factors in such epitaxial QD lasers hence ranging between  $\sim 1.0$  and  $\sim 1.6$  across the optical spectrum. Such results confirm the high quality of the material along with the narrow inhomogeneous broadening [4]. This work is important for integrated technologies on silicon. Last but not least, this OPM method can be applied to any types of semiconductor laser either single-mode, multi-mode, or with complex structures.

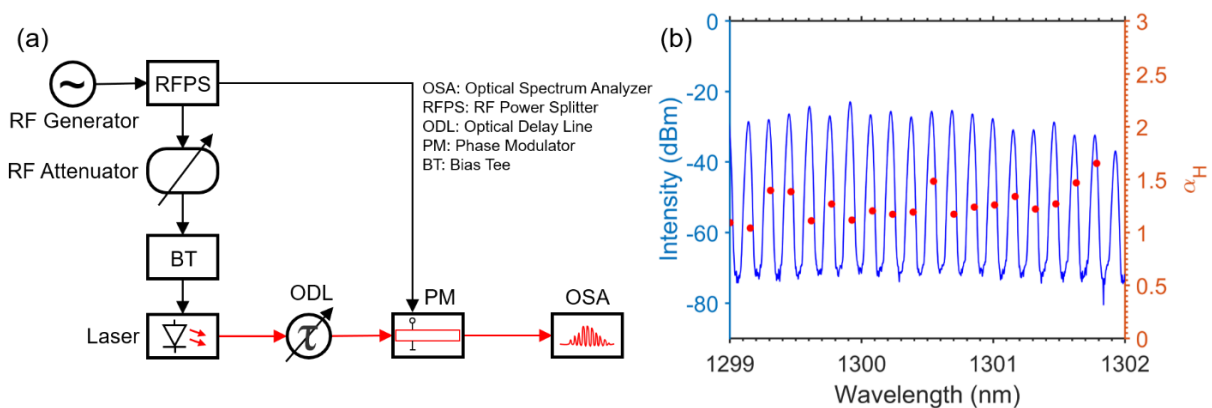


Figure 1. (a) Schematic of the experimental set-up, (b) Free running spectrum (blue line) and spectral dependence of the  $\alpha_H$  factor (red dots) for the silicon-based epitaxial QD laser.

## References

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